



UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
-----------------	-------------	----------------------	---------------------	------------------

10/067,410

02/04/2002

Christopher W. Hill

3380.1US (97-842.1)

8302

24247

7590

11/08/2006

TRASK BRITT

P.O. BOX 2550

SALT LAKE CITY, UT 84110

EXAMINER

LEE, HSIEN MING

ART UNIT

PAPER NUMBER

2823

DATE MAILED: 11/08/2006

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

10/067,410

Applicant(s)

HILL ET AL.

Examiner

Hsien-ming Lee

Art Unit

2823

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --
Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 23 August 2006.
- 2a) ☒ This action is **FINAL**. 2b) ☐ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-28 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1-28 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
 2. ☐ Certified copies of the priority documents have been received in Application No. _____.
 3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

HSIEN-MING LEE
PRIMARY EXAMINER

Attachment(s)

- | | |
|--|---|
| 1) <input type="checkbox"/> Notice of References Cited (PTO-892) | 4) <input type="checkbox"/> Interview Summary (PTO-413)
Paper No(s)/Mail Date. _____ |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948) | 5) <input type="checkbox"/> Notice of Informal Patent Application |
| 3) <input type="checkbox"/> Information Disclosure Statement(s) (PTO/SB/08)
Paper No(s)/Mail Date _____ | 6) <input type="checkbox"/> Other: _____ |

DETAILED ACTION

Comments on the reopened prosecution

1. As a result of an appeal conference conducted on Nov. 18, 2006, this Office action is intended to fix the deficiency of "inherency" that was addressed in the previous Final rejection, mailed on 4/3/2006, under 103(a) as being unpatentable over Chen et al. (US 6,020,259).

Response to the Appeal's Arguments

2. This is in response to the appeal brief filed 8/23/2006.

In view of the appeal brief filed on 8/23/2006, PROSECUTION IS HEREBY REOPENED. A final rejection is set forth below.

To avoid abandonment of the application, appellant must exercise one of the following two options:

(1) file a reply under 37 CFR 1.111 (if this Office action is non-final) or a reply under 37 CFR 1.113 (if this Office Action is final); or

(2) initiate a new appeal by filling a notice of appeal under 37 CFR 41.31 followed by an appeal brief under 37 CFR 41.37. The previously paid notice of appeal fee and appeal brief fee can be applied to the new appeal. If, however, the appeal fees set forth in 37 CFR 41.20 have been increased since they were previously paid, then appellant must pay the difference between the increased fees and the amount previously paid.

A Supervisory Patent Examiner (SPE) has approved of reopening prosecution by signing below:

Art Unit: 2823



Matthew Smith

Supervisor, Art Unit 2823

MATTHEW SMITH
SUPERVISORY PATENT EXAMINER
TECHNOLOGY CENTER 2800

Claim Rejections - 35 USC § 103

3. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

4. Claims 1, 8-10, 12-14, 18-20, 23 and 25-28 are rejected under 35 U.S.C. 103(a) as being unpatentable over Chen et al. (US 6,020,259, submitted by applicant).

In re claims 1, 8, 14, 20, 27 and 28, Chen et al. in Figs. 4-7 and related text, teach the claimed method, comprising:

- causing a chemical reaction (i.e. *TiCl₄ reacts with Si*, col. 3, lines 2-19) adjacent to a surface of one exposed, doped area 30 (i.e. source and drain regions) of a semiconductor device structure to *selectively deposit* (col. 3, line 3) titanium silicide or contact material 36 (i.e. *TiSi₂*) by using a *CVD process* (col. 3, line 4) thereon without reacting material of the one exposed, doped area because the formation of the *TiSi₂* does not consume the underlying doped silicon region 30; and

- subsequently blanket depositing an interconnect material 38 (i.e. a barrier, *TiN*) by using a *CVD process* (col. 3, lines 20 –22) onto the metal silicide or the contact material 36 *after* causing the chemical reaction (col. 3, lines 20-23).

With respect to the interconnect material (TiN) being deposited *in situ* with causing the chemical reaction, Chen et al. do imply a desirability of depositing the interconnect material in situ (i.e. in the same chamber) with causing the chemical reaction because Chen et al. teach depositing the interconnect material 38 and causing the chemical reaction to form titanium silicide with a **same** technique, i.e. the CVD process (col. 3, lines 2-4 and 20-22). Regarding the limitation of “in situ”, it is conventional practice to perform as many processing steps in a single apparatus as possible to avoid contamination from the outside atmosphere. Further, apparatus limitations, unless they affect the process in a manipulative sense, may have little weight in process claims. In re Tarczy-Hornoch 158 USPQ 141, 150 (CCPA 1968); In re Edwards 128 USPQ 387 (CCPA 1961); Stalego V. Heymes 120 USPQ 473, 478 (CCPA 1959); Ex parte Hart 117 USPQ 193 (PO BdPatApp 1957); In re Freeman 44 USPQ 116 (CCPA 1940); In re Sweeney 72 USPQ 501 (CCPA 1947).

Therefore, one of the ordinary skill would have motivated to cause the chemical reaction to selectively deposit metal silicide 36 and deposit the interconnect material 38 onto the metal silicide 36 after and *in situ* with causing the chemical reaction by first providing a silicon-containing ambient (col. 3, lines 5-10) into the CVD chamber; and, *within the same CVD chamber*, subsequently changing the ambient inside the chamber from silicon-containing to nitrogen-containing (col.3, lines 20-22) to deposit the interconnect material 38. The motivation and suggestion for doing so is to provide a better process for forming the metal silicide and the

Art Unit: 2823

interconnect material in the same reaction chamber to avoid undesirable contamination from external atmosphere.

In re claims 9, 10, 25 and 26, Chen et al. teach that depositing the interconnect material (TiN) comprises *blanket* depositing the interconnect material (col. 3, lines 20-23) and *patterning* the interconnect material by removing the excess interconnect material from outside of the contact hole (Figs.6-7).

In re claims 12, 13 and 23, Chen et al. further teach depositing an electrically conductive layer 40 over the interconnect material 38 and patterning the electrically conductive layer 40 by removing the excess electrically conductive layer from the outside of the contact hole (Fig.7).

In e claims 18-19, Chen et al. further teach that depositing the interconnect material comprises reacting a metallic precursor (i.e. TiCl_4 or titanium tetrahalide) with a reactant comprising an activated species (i.e. N_2) (col. 3, lines 20-24).

5. Claims 2-5 and 21-22 are rejected under 35 U.S.C. 103(a) as being unpatentable over Chen et al. as applied to claims 1, 8-10, 12-14, 18-20, 23 and 25-28 above, and further in view of Chang et al. (US 5,043,299).

In re claims 2-4 and 21, Chen et al teach the claimed method, as stated above, but fails to teach exposing said at least one exposed, doped area of the semiconductor device structure to a plasma comprising an activated species of at least one of nitrogen, hydrogen, and ammonia; and cleaning the semiconductor device structure.

Chang et al., in an analogous art of selective deposition, teach a pre-deposition preparation by exposing the exposed, doped area of the semiconductor device structure to plasma comprising an activated species of at least one of nitrogen and hydrogen (Fig.1 and text in col. 3,

Art Unit: 2823

lines 14-26; col. 4, lines 10-15); and cleaning the semiconductor device structure (col.7, lines 1-11) for the purpose of removing contaminants including undesirable oxide and moisture (col.2, lines 15-28; col.6, lines 48-61).

Therefore, one of the ordinary skill in the art, at the time the invention was made, would have been motivated to expose the exposed, doped area of semiconductor device structure of Chen et al to the plasma comprising either nitrogen or hydrogen; and cleaning the semiconductor device structure, as taught by Chang et al., since by doing so it would be beneficial to the subsequent selective deposition. (col.2, lines 15-28; col.6, lines 48-61, Chang et al)

In re claim 5, Chen et al in view of Chang et al. further teach that said cleaning includes employing a cleaning agent comprising chlorine. Particularly, Chang et al. indicated using a halogen-containing gas, which would include chlorine and fluorine for the cleaning purpose. (col. 7, lines 5-6).

In re claim 22, Chen et al in view of Chang et al. do not teach exposing the semiconductor device structure to a nitrogen-ammonia plasma. However, the selection of the cleaning plasma for said exposing step is obvious because it is a matter of determining optimum process condition by routine experimentation with a limited number of species. In re Jones, 162 USPQ 224 (CCPA 1955)(the selection of optimum ranges within prior art general conditions is obvious) and In re Boesch, 205 USPQ 215 (CCPA 1980)(discovery of optimum value of result effective variable in a known process is obvious). For example, the cleaning plasma can be selected for the particular surface to be cleaned, dependent upon the material of the particular surface. (col. 3, lines 14-26, Chang et al.) In this case, the applicant is required to demonstrate

Art Unit: 2823

the criticality, generally by showing that the claimed plasma would achieve unexpected results relative to the prior art. See M.P.E.P. 2144.05 III.

6. Claims 6 and 7 are rejected under 35 U.S.C. 103(a) as being unpatentable over Chen et al. as applied to claim 1 above, and further in view of Kolar et al. (US 5,162,259).

Chen et al. teach the claimed method, as stated above, but fails to teach cleaning the semiconductor device structure after said depositing said metal silicide, wherein said cleaning includes employing a cleaning agent comprising at least one of chlorine, hydrochloric acid, and hydrofluoric acid.

Kolar et al. in an analogous art teach forming a silicide layer 40 followed by cleaning the semiconductor device structure employing a cleaning agent comprising hydrochloric acid, prior to depositing an interconnect material 38. (Fig.4 and text in col. 21-23)

Therefore, one of the ordinary skill in the art, at the time the invention was made, would have been motivated to utilize said hydrochloric acid as cleaning agent as taught by Kolar et al., in the method of Chen et al. to clean the surface of said deposited metal silicide; and then to deposit said interconnect material, since by doing so it would improve the adhesion between adjacent layers.

7. Claims 11 and 24 are rejected under 35 U.S.C. 103(a) as being unpatentable over Chen et al. as applied to claim 1 above, and further in view of Kim et al. (US 5,821,164).

Chen et al. do not teach *selectively* depositing the interconnect material (TiN).

However, using selective deposition for forming TiN in a contact hole has been widely used in the art, as evidenced by Kim et al. (col. 4, lines 24-27). Kim et al. teach selectively

Art Unit: 2823

depositing the interconnect material 16 (col. 4, lines 24-27), such as TiN, in a contact hole 15 (Figs. 2E~2F).

Therefore, it would have been obvious to one of the ordinary skill in the art, at the time the invention was made, to use the selective deposition, as taught by Kim et al., for forming the interconnect material of Chen et al, since by this manner it would provide a better means for controlling the desired depositing location and thickness of the interconnect material.

8. Claims 15-17 is rejected under 35 U.S.C. 103(a) as being unpatentable over Chen et al. as applied to claim 1 above, and further in view of Shinriki et al. (US 6,001,729).

Chen et al. teach that causing the chemical reaction comprises reacting a metallic precursor (i.e. $TiCl_4$ or *titanium tetrahalide*) with silicon (col. 3, lines 2-19) but is silent as to the silicon source being a silicon compound.

Shinriki et al., however, teach causing a chemical reaction via reacting metallic precursor (i.e. $TiCl_4$) with a silicon compound (i.e. SiH_4 or silane) (col. 12, lines 37-39) adjacent to a surface of one exposed, doped area 38 of a semiconductor device structure to selectively deposit titanium silicide.

Therefore, it would have been obvious to one of the ordinary skill in the art, at the time the invention was made, to use the silicon compound, as taught by Shinriki et al., as the silicon source of Chen et al., since by this manner it would satisfactorily cause the chemical reaction to form the titanium silicide.

Response to Arguments

9. Appellants arguments filed 8/23/2006 have been fully considered but they are not persuasive.

In the rejection under Chen (page 7 of Appeal Brief), Appellants argued that Chen et al. do not teach or suggest depositing titanium silicide followed by titanium nitride deposition in situ (last paragraph, on page 7 of Appeal Brief) because “the titanium silicide deposition process disclosed in Chen **could** be effected in a different chamber from the titanium nitride deposition process disclosed in Chen.” (first paragraph on page 8 of Appeal Brief) (Emphasis added) In addition, Appellants maintained that “[I]f it would have been obvious to conduct deposition process that require at least one different reactant *in situ* with one another then there surely would have been some disclosure to that effect in the prior art. (fourth paragraph on page 8 of Appeal Brief).

In response to the assertions that depositions of titanium silicide and titanium nitride “**could** be effected” in different chambers and no suggestion of performing reaction and deposition “*in situ*”, it is submitted that the arguments are based on speculation without any factual evidence either taught or suggested in Chen reference.

On the contrary, Chen et al. do imply a desirability of forming titanium silicide 36 and titanium nitride 38 in the **same** chamber. Chen et al. teach causing the chemical reaction (i.e. $\text{TiCl}_4 + \text{Si} = \text{TiSi}_2$ and $\text{TiCl}_4 + \text{SiO}_2 = \text{Ti}$, col. 3, lines 5-10) using a **CVD process** (col. 3, lines 2-4) to form the titanium silicide 36; and with the **same process** changing the ambient from silicon-containing to nitrogen-containing to form the interconnect material (i.e. titanium nitride 38).

Therefore, one of the ordinary skilled in the art would have been motivated to cause the chemical reaction (i.e. to form titanium silicide) using CVD process and then deposit the interconnect material (i.e. to form titanium nitride) using CVD process in the same chamber (i.e.

in situ), since by conducting in the same chamber it would eliminate contamination from external atmosphere.

Appellants asserted that “the teachings of Chen are limited to introducing single sets of reactants into a chamber while a semiconductor substrate resides therein.” (last paragraph on page 8 of Appeal Brief)

Contrarily, Chen introduces two sets of reactants in the method, i.e. a first set of reactant comprising silicon-containing, which is used to form titanium silicide and a second set of reactant comprising nitrogen, which is used to form titanium nitride.

In the rejection under Chen in view of Chang (page 10 of Appeal Brief), Appellants further argued that “the Examiner has not shown any art that discloses use of such a plasma.” (first paragraph on page 11 of Appeal Brief)

In response to the foregoing argument, it is submitted that the cleaning plasma can be selected for cleaning a particular surface, dependent upon the material of the particular surface to be cleaned. (col. 3, lines 14-26, Chang et al.) In this case, the applicant is required to demonstrate the criticality, generally by showing that the claimed plasma would achieve unexpected results relative to the prior art. See M.P.E.P. 2144.05 III.

In the rejection under Chen in view of Kolar (page 11 of Appeal Brief), Appellants did not clearly indicate why the rejection is improper.

In the rejection under Chen in view of Kim (page 11 of Appeal Brief), Appellants asserted that “a *prima facie* case of obviousness has not been established against either claim 11 or claim 24” (last paragraph on page 11) because, in Kim teachings, “interlevel layer 14a covers the entire substrate 11, and that the entire upper surface of interlevel layer 14 appears to be

Art Unit: 2823

exposed”; “the formation of conductive layer 16 must be followed by an etch-back” in order “to remove conductive material from the upper surface of the interlevel 14a and, thus to define conductive lines 16 within the contact hole 15.” Thus, Appellants concluded that “the deposition of the conductive layer 16 would certainly not be selective.” (first paragraph on page 12).

On the contrary, Kim et al. clearly teach that the conductive layer 16, such as TiN, is “**selectively** deposited on the exposed surface of the interlevel layer 14a.” (emphasis added)

In the rejection under Chen in view of Shinriki (page 12 of Appeal Brief), Appellants did not clearly indicate why the rejection is improper.

For the above reasons, the rejections, as stated in this Office action, are deemed proper.

Conclusion

10. Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire **THREE MONTHS** from the mailing date of this action. In the event a first reply is filed within **TWO MONTHS** of the mailing date of this final action and the advisory action is not mailed until after the end of the **THREE-MONTH** shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than **SIX MONTHS** from the date of this final action.

Art Unit: 2823

11. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Hsien-ming Lee whose telephone number is 571-272-1863. The examiner can normally be reached on Monday, Tuesday and Thursday (7:30 ~ 6:00).

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Matthew Smith can be reached on 571-272-1907. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

Hsien-ming Lee
Primary Examiner
Art Unit 2823

Oct. 31, 2006

HSIEN-MING LEE
PRIMARY EXAMINER


10/31/06